COMPUTERS
IN THE
BIOLOGY CLASSROOM

A Study Guide for Teachers

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Utpal Mallik

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
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The author wishes to thank Shri J.S. Raju, Editor of Computers Today for permitting the re-use of portions of the aforesaid articles in Modules 3,4,5 and 6 of this Guide.

Foreword

At the present stage of development in India, integration of computers in the prevailing pattern of educational technology is like introduction of the first steam engine in the industrial set-up of the 18th century England. The latter was not 'prepared' to use the new invention—it had to grow over a stretch of time to find various productive uses of the steam power.

The first steam engine was not used either for transportation or for mass manufacture Built by Thomas Newcomen in 1702, it was used for pumping water out of deep coal mines in England The steam engines of the later period, designed by James Watt, turned wheels to work the blast furnaces in iron mills and ran sugar mills in the West Indies. Only in 1829, George Stephenson demonstrated that the steam engine could be used for speedy transportation — for running locomotives, for instance In the course of time, steam power revolutionized industrial manufacture in England

This paragraph from the history of modern technology shows that a technological invention does not necessarily find an immediate and the most effective use in the society in which it appears Its manifold uses grow in rhythm with the socio-economic developments of the time There were people in the 18th and 19th century Europe who could create a new range of uses for the first steam engine, and it grew with the changing set of demands made on it

The foregoing observations also point to the fact that a new invention and its optimum use are not always symbiotic The same holds true for the use of computers as an educational technology in India today. At this point we must realize that a piece of hardware, however powerful it may be, cannot revolutionize a given situation. Thinking, planning and hard-working minds have to put the hardware to productive uses. The first generation of computer users in the Indian class-rooms — teachers and students alike — have to be creative in their approach to this new technology. In fact, their attitude to the relational pattern between data — information — knowledge, must change and they should be prepared to accept the dynamics of the learning processes ushered in by the computer. The new situation may lead to many unconventional and unfamiliar classroom practices which might as well change the prevalent heuristic and algorithmic strategies beyond recognition. Perhaps the relationship between different units of 'knowledge quantum' would be continuously changing and shifting towards more effective patterns of relationship.

The scope of school computing has widened in recent times due to unprecedented developments in the hardware technology and vastly improved and imaginative software techniques Computer-assisted learning provides diverse opportunties which would otherwise be constrained by limitations of traditional resources We should try to make the best use of the new tool which promises, and which has the potential, to bring about changes in what pupils learn and how they learn it.

Establishment of a meaningful relationship between the computer and the curriculum depends largely on the motivation and training of teachers This is an area where adequate input is required I believe, this Study Guide, written by Utpal Mallik, is one such input By training a biologist, and one who took to school computing with cautious enthusiasm, Dr. Mallik has developed the Study Guide for use as a resource material for training of teachers under the Project titled 'Strengthening of teaching of modern biology and biotechnology in schools through use of computer software as teaching aid '

The Project is financed by the Department of Biotechnology (DBT), Ministry of Science and Technology, Government of India to introduce modern teaching aids in schools and to extend the potential of computer-based learning to remote areas of the country. It proposes to create a base of trained teachers who would combine the conventional teaching of biology and biotechnology with emerging methods of teaching-learning with the aid of modern tools

The DBT implements the Project with the help of the Ministry of Human Resource Development. The latter has alloted different responsibilities to the National Council of Educational Research and Training, Kendriya Vidyalaya Sangathan and Navodaya Vidyalaya Samiti. The NCERT has taken up the responsibility of providing software support by promoting indigenous software for Project schools, and of coordinating inputs in the form of training materials and other print materials. Dr B. Ganguly, Professor and Head of Department of Education in Science and Mathematics, NCERT has accepted, with his characteristic enthusiasm, the responsibilities of the Chairman of the in-house implementation committee bestowed upon him by the Council.

I sincerely hope that this publication, which is not merely a reading material but an activity guide as well, would serve its purpose. Its success, however, would depend in substantial measure on how imaginatively it is used

New Delhi
7 February 1990

P.L. Malhotra
Director
National Council of
Educational Research & Training

Preface

This is not a step-by-step manual containing a list of dos and don'ts for computer use in schools. Instead, this Study Guide attempts to explain the nature and modes of some computer uses and suggests how various species of computer programs may be tried fruitfully in the biology classroom.

Had there been a collection of programs readily available before the author, custom-made for the biology classroom, perhaps some of them could be used to illustrate the points made in various modules Certainly a bunch of courseware on specific topics would have been a strong support to the author of this Guide as well as to the Project itself. But on the other hand, the modules, as they are now, look more broad-based and widely applicable than thay would have as a working manual in support of a set of software packages. Such manuals come with the commercial software packages anywary. I believe, in its present form, this Guide would be as useful to biology teachers as to all teachers, especially because much of the software it deals with is content-free, i.e. tool software which can be used in a variety of subject areas.

The outline of this Guide was approved by an Expert Group (for preparation of reading materials for this Project) in a meeting chaired be me and held on 10 July, 1989 on NCERT campus The meeting was attended, among others, by Sh. P. Sarkar (Adviser, DBT), Dr. J.R. Arora (Director, DBT), Sh V.K. Gautham (Teacher, Navodaya Vidyalaya, Faridabad), Km A. Gupta (Teacher, Navodaya Vidyalaya, Sardhana), Prof. Salil Bose (JNU, New Delhi), Prof. M R. Das (CCMB, Hyderabad), Prof. K. Dharmalingam (Madurai Kamraj University, Madurai), Dr. R.P. Gupta (DESM, NCERT), Dr R.R Saxena (DESM, NCERT) and Dr Utpal

Mallik, the author of this Guide. The manuscript of this Guide was sent to all of them for their suggestions for its improvement Some of them have sent back their critical comments. I am thankful to them all

My special thanks are due to Dr. Utpal Mallik for having undertaken the job of writing this Guide and completing it within a remarkably short period of time without much software support

Smt Kabita Bose, lecturer in this Department, dug out the right reference material at the right moment and went through every module meticulously Her ungrudging help is appreciated

The character of a publication like this, however, would fast change as application programs and courseware dedicated to particular school subjects are available for general use Until then, I hope, this Guide would help initiate some meaningful activities with computers in the biology classroom

New Delhi
7 February 1990

B Ganguly
Head of Department of
Education in Science and Mathematics
NCERT

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Introduction

> *Thinking about the computer's role in education does not mean thinking about computers, it means thinking about education.*
>
> Alan Ellis
> *The Use and Misuse of Computers in Education*
> *(McGraw-Hill 1974)*

The idea of using computers as an aid to teaching-learning of school subjects is slowly gaining ground. Although few would be ready to define the overall validity of using computers in the school classroom, the spread and diversity of computer applications in schools is growing wider. Some of these applications will flourish and others fade in course of time. But the school curricula are still designed solely for paper-pencil environment So attempting to integrate a different technology into paper-pencil classroom practice is not as trivial a matter as some computer enthusiasts would have us believe. It's a challenging job.

An assessment of the possibilities that the computer offers as a teachig aid involves reappraisal of present methods and testing of new ideas. This is likely to result in silent curriculum innovations, development of new approaches, changes of emphasis and introduction of different teaching-learning styles. The use of computers may stimulate new thinking in relation to *how* and *what* is taught in the school.

The current enthusiasm for young children and teachers using the computer as an aid to the curriculum, however, raises many intriguing issues. Chief among them involves the notion of a tool outside education — say, in business or industry and that in education. In business and industry, computers perform some existing tasks But there are not many visible tasks that the computer can be assigned to in the classroom

So the user of this tool, the teacher, has to be creative with and critical about his/her educational computing practice. Computers are an educational novelty It is easy to do unconventional things with them. If the teacher is convinced that some of these unconventional practices enhance the teaching-learning process, those practices will be justified. There is no fixed prescription for use of any tool New uses for tools is a part of the process of evolution of tools and tool-use. Computer use in education has no history to speak of. So we have a wide field for explorations to be made by teachers

Apart from skills for using the tool, there is growing need for teachers to be able to get the best out of the powerful computer systems that are available — hardware and software The teacher has to be able to judge the curricular implications and pedagogical effectiveness of available software. The use of computers may allow a new level and more rewarding style of classroom experimentation — enabling both teachers and students to carry out more exciting activities. The technology will provide not only new learning tools but it will also make new learning demands. It will not only change *how* a school subject is taught (biology, for instance), but *what* biology is taught Biologists should look critically at the merits and potential of micros and their applications to assess their value and future in biology teaching This should lead to development and design of new learning materials

Interactive simulations, modelling, role-playing, decision-making, information retrieval, to name a few modes of computer application in the classroom, hold promise for novel learning opportunities In science laboratories, computers can help plan and perform experiments, analyze results and store and retrieve experimental data Through interactive simulations, it is possible to concretize some of the abstract ideas or represent phenomena that cannot be visualized by simple observation and explanation In other words, the computer can help overcome some of the limitations imposed on education by conventional resources.

The most versatile and valuable teaching machine is the teacher. The computer is not a surrogate teacher, it is there for the teacher to use when needed. But to use a micro successfully is demanding. It takes time to prepare materials and often requires restructuring of lesson plans In many cases, the role of the teacher has to change. And children whose experiences are computer-derived cannot be appropriately assessed by traditional methods of evaluation which measure students' ability to reproduce discrete facts on demand. It is important to discover what students are learning with computers that traditional tests do not measure We do not know for sure the cognitive consequences of learning in a computer-enriched environment But a lot of curricular components will change as a result of integration of the computer into the curriculum. We have to be prepared for that

As we intend to use computers in teaching-learning of biology and biotechnology, we have to ensure that the teacher is able to link activities done on the computer to the general education of children This means, the biology teacher should be able to

i define his/her immediate objective (of using the computer in a particular context),
ii organize appropriate learning experiences for children,
iii select useful software, and
iv evaluate children's progress

This study guide is meant for biology teachers, and would guide them through a training course to

i increase their awareness to computer-aided learning,
ii introduce biology teachers to the possible applications of the computer in their own subject area as a realistic option within their teaching strategy,

iii. introduce biology teachers to possibilities of integrating computers into the biology curriculum (i.e. into the course content and teaching methods) where appropriate, and
iv. try to establish standards to be adopted in the production and evaluation of computer-based learning materials.

Having done the activities based on the modules in this guide, the teacher is expected to be able to ·

i. operate a computer system,
ii. define computer-based learning modes,
iii. select relevant applications of these modes of use within their subject area,
iv make out between useful and useless software,
v. apply computers as an extension to and/or support for his/her teaching methods,
vi provide guidelines for course development based on sound knowledge of appropriate software standards and other issues, and
vii recognize where computers can enrich the learning environment and initiate changes in teaching methods

This study guide is not on computers, rather it is about possible modes of computer use in the classroom—admittedly biased towards the biology classroom Yet, the first module is on microcomputers. It introduces a computer system to the uninitiated; it outlines the very bare minimum information about computers. So it is expected that all training courses would start with the first module. But that is almost all that one needs to know about computers to be a computer user in the classroom. The rest of the modules would provide random access, no definite sequence is required to be followed. In fact, it is not even necessary that all the modules should be covered in every training course. Much of what is covered in a training session would largely depend on availability of software, hardware accessories and other factors.

Each module in this guide has essentially two parts. The first part is about some general theoretical considerations pertaining to the particular area of application. In the other part, I have tried to be more specific, dealing with situations workable in the classroom

The activities that have been listed (at the end of the first part of each module) are only suggestive. They are not prescriptive Many more useful activities, I believe, would be tried by the training faculty In fact, the objectives listed at the beginning of each module should determine the activities to be performed.

I hope the short list of books for additional reading (in every module) would be of some help to teachers

MODULE 1 : WHAT'IS A COMPUTER

Aims of this module:

1. to introduce you to the basic units of a microcomputer
2. to enable you to set up a microcomputer system
3. to enable you to use the machine.

Objectives of this module: It is expected that having gone through the first half of the module and having done hands-on exercises that might emanate from the second, you should be able to :

1. Explain commonly used microcomputer terminology
2. Identify different subunits of your computer system and state their functions
3 Connect different subunits of your system together
4 Use disk-drive, monitor, printer and other available peripherals
5. Load and run a program
6 Format a disk
7 Make back-up copies of a disk

What is a Computer

This first module of the study guide outlines the essential features of a microcomputer system It is meant to acquaint you with the basic characteristics of the machine which you are going to use as a tool that is likely to enrich your classroom in some ways

Like all other modules of this guide, this one too has two parts. The first part of the module introduces the primary components of a microcomputer and explains its operations and basic functions. The emphasis is on the role of the microcomputer as a means of processing information. The different ways in which information can be both fed into a microcomputer and retrieved are outlined.

The other half of the module (Know Thy Machine) gives a brief description of *the computer* that you are going to use — an IBM PC compatible machine

A Computer System

Computers are involved in processing information By information we mean numbers, digits, letters, words, picture, sound, etc. What the computer can do is change these symbols or sound according to instructions that we, the users, give it Simple examples of such change could be *addition* of two numbers or alphabetic *sorting* of names of students in a class Surely we can do these without a computer, but if we are faced with large numbers to add or many names to sort, then these tasks become difficult A computer makes these difficult tasks easy. The above examples are, of course very simple types of processing of information Computers are employed to carry out more complicated ways of changing information. In order to carry out any information processing, however, it is necessary to instruct the computer on how to do the required changes This is done by different steps which must be carried out by the computer to change, say, the numbers or names. This set of instructions, called a computer program, is necessary because while the computer can change information in complicated ways, and rapidly, the machine does not understand why these changes are being made or how they should be made This lack of understanding is the difference between the ways in which computers and humans process information.

A typical computer system consists of a *central processing unit* (CPU), *internal memory* and *peripheral devices.* The CPU is the main part of a computer It operates at a higher speed than the rest of the computer system. Input and output devices or backing storage devices are peripherals.

Central Processing Unit The CPU is the so-called brain of the computer and is where the actual processing or changes of information takes place A part of the CPU — the *control unit* — reads the instructions, directs the flow of information and instructs, in turn, other parts of the computer what to do The other part of the CPU, the *arithmetic/logic unit*, carries out the changes to the raw information Both these parts are found on the same piece of silicon which is called the *microprocessor* A microprocessor is an *integrated circuit* (IC), consisting of different electronic components and the connections between them, which has been produced on the surface of a small flat piece of silicon — a substance which conducts electricity but not as well as metals do, and hence called *semiconductor*. It is the CPU which largely determines the power of the computer This power is manifested in different ways in the type of commands that can be executed, in the amount of internal memory of the computer that can be accessed directly, the speed at which various commands or instructions are executed and the amount of information that can be transferred from the CPU to the internal memory at one time. The speed is expressed in terms of the number of processing cycles that can be carried out each second. The amount of information that is processed or transferred by the CPU at one time is expressed in terms of *bits* A bit is one binary unit of information such as a "0" or "1". Each number or letter that is typed from a *keyboard*, the most commonly used input device, is represented by eight binary units. One group of eight bits is called a *byte*. CPUs that process and transfer one byte of information at a time are called "8-bit CPUs" while those which process and transfer 32 bits at a time are "32-bit CPUs"

Internal Memory The internal memory consists of a number of chips (a piece of silicon with an electronic circuit is called a *chip*) where the computer stores information — the immediate access store It is used by the CPU at high speed and without any mechanical movement. This store is divided into units called *locations*, each of these locations has an *address*, which can be referred to by a program as a name or a number

The immediate access store is used to store information temporarily so that these chips can be used again for other programs Once the computer is switched off, the internal memory loses all the information it had had. This temporary memory is usually called RAM (random access memory) Random access because the time taken to retrieve information from one part of this memory is independent of the previous part of the memory searched. The memory locations can be accessed at random For example, it takes the same time for the CPU to get information from memory location number 247 as it does from the location number 4836.

On the other hand, it is necessary to store in the internal memory some information or instructions For example, we cannot teach the computer how to recognize the letters on the keyboard every time we switch on the machine If this happened, then our computer would be useless. This is why some instructions or programs are stored permanently in the computer. This type of permanent internal memory is called ROM (*read-only memory*) The computer can *read* the set of instructions contained in these chips but these instructions cannot be changed in any way ROMs are used to store programs essential to the normal running of the computer

Input/Output Devices The computer has to be fed with information in order for the machine to process it Input devices accept *data* (the term is used interchangeably with *information* — though they are somewhat different; see the Glossary) from outside the computer system and transmit it to the CPU

The most commonly used input device is the *keyboard.* This is very similar to the standard typewriter keyboard although, usually, there are extra keys associated with the control of the equipment The keyboard sends data straight to the computer (*direct data entry*) or it may encode data onto a medium so that it can be read into the computer later This is called *off-line* preparation

A different way of interacting with a computer is by using a small device called *mouse*, which is moved by hand over a small area on the desktop The mouse consists of a small ball which turns as the mouse is moved to and fro over the desk. Two small wheels are moved by this ball which turns as the mouse is moved and the computer uses this information to calculate the distance and direction that the mouse has been moved

Other types of input devices which carry out the same type of task as the keyboard and mouse are *joysticks* and *game paddles* A more recently developed way of reaching information to the computer is by speaking to it. Apart from these, a variety of other input devices are available for communicating with the computer

Output devices receive data from the CPU and change it to a form which can be used outside the computer system The most common form of output from a microcomputer comes on a screen — the *visual display unit* (VDU). The display device is usually a *cathode-ray tube* (CRT) CRTs can be regular television receivers and black and white or colour monitors. Another way of reading information that has been processed by a computer system is to get a printout of what is visible on the CRT screen. Printers provide *hard copies* on paper.

External Storage Remember our examples of alphabetic sorting of students' names ? More often we save the output of such processing and the instruction sets (or programs) that make such output possible so that thay can be used again at a later stage. But how do we save these ? They are saved by the use of external storage devices which store, retrieve and transport information Most devices use some form of magnetic medium. The magnetic material can be attached to different bases — a thin strip for cassette tapes, a plastic disk for floppy disks or a metal record for hard disks The advantage of magnetic media over RAM is that information can be written to and read from a magnetic medium and will remain there even when the computer is turned off

The most widely used way of saving information externally from the computer's internal memory is via a disk drive The disk drive is an electromagnetic device which puts information onto and reads information from a magnetic disk The commonly used disks that are used with microcomputers are referred to as *floppy disks* A floppy disk is shaped like a small 45 RPM record but is made of a flexible (hence called floppy) magnetic material similar to the one used in audio tapes The floppy disk is protected by a cardboard cover with a small opening This opening allows the disk drive to read and write information on the disk

A more expensive form of external storage than floppies is a *hard disk* A single hard disk can store much more information and it can be transferred from external to internal memory up to twenty times faster than with a floppy disk

What Makes Things Run

So far I have been describing a general view of the machine You shall get a much closer look as you start using your machine. But this machinery comprises only the physical parts of a computer — the *hardware*. A piece of machinery, however, does not work on its own even if it is as costly as a computer There must be a set of instructions which controls the flow of information from input to output and which determines how the information is to be processed. These instructions, which are not physical entites but are something like the script of a play which is memorized by the actors and spoken at appropriate moments, exist within the physical components of the computer. These instructions are computer programs or *software*.

It is the software which makes the machine work, at the user's instance. Software, however, is a general term for programs, which are basically of two types : *systems programs* and *applications programs*.

A systems program is one of the programs that controls or improves the performance of a computer system. The most obvious example is *operating system* of a computer It controls the overall operation of the machine.

An applications program is a specialized program which enables a computer to be used for a specific application. An *application package* is an applications program or set of programs, together with all the documentation necessary for its use. A program that helps a biologist produce graphs of his experimental results is an applications program.

In the next part of the module, you will get to know about the particular computer system that you are going to use — both theoretically and through hands-on experience.

For Additional Reading

1. *Computers Today*
   by Donald Sanders.
   McGraw-Hill Asian Student Edition 1983
2. *Your IBM PC Made Easy*
   by Jonathan Sachs.
   McGraw-Hill International Edition 1988.

Know Thy Machine

This part of the module is no substitute for the User's Manual (or whatever it is called) that must have come with your computer system. In fact, you should consult the User's Manual for every type of operation. This part of the module is for you to be able to get started with a few very specific pieces of information which you shall get in greater detail in the User's Manual. Meanwhile, here is some basic information about your computer for a quick glance.

System Specifications

A. *The Computer* Yours is a 'personal computer' (PC) compatible with IBM PC (IBM stands for International Business Machine, the world's largest computer manufacturer). In plain language, it means that you can run *most* software written for IBM PC although your computer is not an IBM product. A PC is a general purpose computer designed for operation and use by one person at a time All personal computers are microcomputers (although the reverse is not necessarily true). The central processing unit of your PC is an integrated circuit called the 8088, made by Intel Corporation.

While most microprocessor clocks (the reference timing source in a system) operate in the range of 1 to 10 MHz, the one in your system operates at 4.77 MHz The computer has an internal memory of 640 kilobytes.

The operating system, MS DOS version 3 2, is sold by the company named Microsoft (hence MS). In fact, MS DOS is available on many computers that use the Intel 8086 or 8088 for their CPUs

Your machine has 8 expansion slots or sockets which can hold printed circuit boards. Not all slots would be in use when you start using the machine. Some of them will. The boards, often called *option boards*, operate various devices such as disk drives, printers, monitors, etc.

The machine has two RS 232C *serial ports* and one *parallel port* (see the Glossary). The RS 232C ports are used for making the connection between two computers or between a computer and a printer or some other pheripheral devices. The parallel port can be used to connect to a printer having a parallel interface.

B. *The Peripherals* With 84 keys, the QWERTY type *keyboard* (including 10 *function keys)* is your primary means of communicating with the computer. The keyboard has several groups of keys in addition to the standard typing keys. The tables below give a brief description of key functions. The User's Manual gives you further detail.

I. Key Functions on the PC Keyboard

Key	*Name*	*Function*
F_1 Through F_{10}	Program function keys	Varies with program
Esc	Escape	Varies with program Often lets you 'escape' from a program being run
→| |←	Tab	Varies with program Usually similar to the tab key on a typewriter
Ctrl	Control	To enter a control character, hold down CTRL and press a typing key The function of a control character depends on the program To reboot the PC, hold down CRTL and ALT and press DEL

⇧	Shift	Shifts typing keys from lower- to uppercase Shifts numeric keypad from numeric entry to cursor control functions or back
Alt	Alternate	Enters control characters. Function depends on program being run. Hold down ALT and press a typing key
←	Backspace	Backspaces the cursor
↵	Enter	Ends a line Enters a command
PrtSc	Print Screen	Prints information displayed on monitor screen
Caps Lock	Caps Lock	Alternately locks typing keys in uppercase and returns them to lowercase.
Num Lock	Num Lock	Alternately locks numeric keypad in numeric entry function and curser control function
Scroll Lock/ Break	Scroll Lock/ Break	Interrupts a running program
01234 56789 0 − +	Numeric keypad/ Cursor control keypad	Enters numbers and cursor control comands, depending on status of NUM LOCK and SHIFT

II. Three Functional Parts of the Keyboard

I	*Function keys*	Ten keys on the left side of the keyboard, marked F_1 through F_{10}, are called function keys A function key is designated to perform a specific function each time it is pressed What function it performs will depend upon the specific program loaded into the computer Most commonly, the keys 1 through 4 are used
II	*Typing keys*	Located at the centre of the keyboard are QWERTY typewriter keys They are used for typing Using shift keys, one can shift the case of the letter, i.e from lower to upper and from upper to lower
III	*Numeric keys*	To the right of the QWERTY keys is the numeric keypad. The use of the system determines the function of these keys. Either numbers or other functions will be performed using these numeric keys, depending upon the setting of the NUM LOCK key

You have two *disk drives*, each with 360 kilobyte capacity. They are meant for 5¼" diskettes. The left-hand drive is drive A and the right-hand drive drive B. When you use the DOS disk, insert it in drive A.

The 12" *colour monitor* will give you 320 × 200 pixel resolution. Epson's LX 800 *printer* (or compatible) is the other output device that you are going to use. It is an eighty column dot matrix printer which runs reasonably fast, printing 180 characters per second.

A 1 KVA servo-controlled *voltage stabilizer* would protect your valuable computer system from voltage fluctuations.

Suggested Activities

1. Assemble the PC and its peripherals.
2. Load the operating system.
3. Boot/reboot a program.
4. Format disks.
5. Create back-up copies.
6. Use all sections of the keyboard in different situations.
7. Run available application programs.
8. Use all available I/O devices.

MODULE 2 : COMPUTER USE IN THE CLASSROOM

Aims of this module.

1. to introduce you to computer uses in the classroom through different kinds of programs
2. to emphasize that it is important for you to find out for yourself how best you can make use of a computer program to the best of your curricular advantage

Objectives of this module. Having done the activities indicated in this module, you should be able to .

1 classify educational software as drill-n-practice, modelling, simulation, information handling, etc

2 list teaching points in a program and indicate classroom strategy for its successful use

3. identify possible learning outcomes of a program

4 indicate follow-up activities emerging out of a program

Computer use in the Classroom

The point of using a computer in the classroom is to extend, alter and enrich the normal run of activities. As a resource, the computer supports the learning which is already taking place. With appropriate software, it can support a wide range of activities and children can benefit from it individually, in pairs or in large groups.

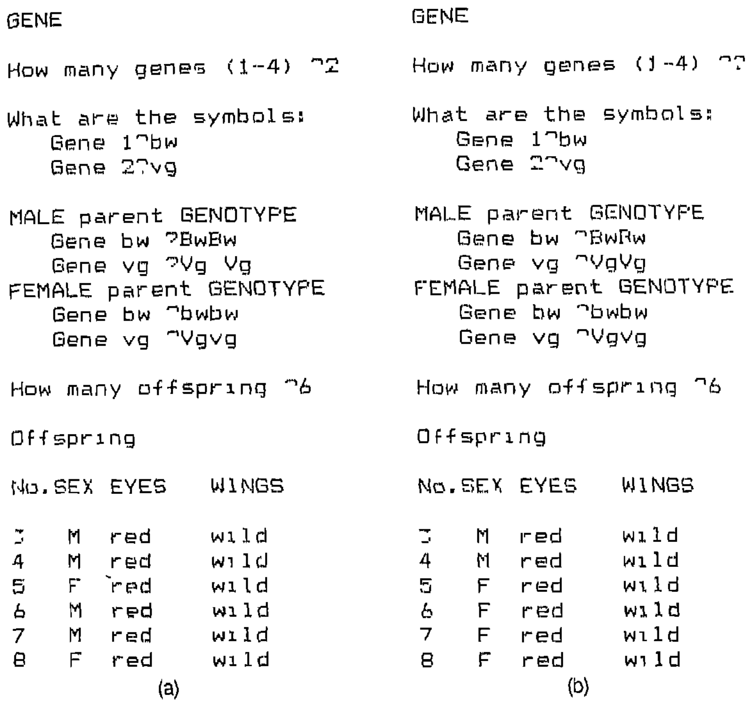
It is not easy, however, to decide what is appropriate software. You have to use your own judgement.

The number of programs to cover every area of learning even within a single school subject is indeed very large. Think about the organization of the software resource, the time taken for every student to use that resource, and the number of machines available. Think also of the dangers inherent in using a program with a class of students only because it is there, although many 'closed' programs (i.e. those on various *topics* of the syllabus), used wisely, may help a student with a particular problem.

The other significant approach can be to promote the use of 'open-ended' or content-free software. This allows you to use it in many different ways. Open-ended software, however, requires the teacher to spend a fair amount of time learning to use it, and often to spend an equal amount of time in setting it up for pupils to use. But the great benefit is that the number of programs you will need to use is relatively small.

This module is meant to help you see where the microcomputer provides opportunities to do more *within* the present system than traditional methods allow.

Turning to biology, there are four major constraints which limit the scope of exploration of the subject in the school. These are the limitations of time, space, cost and skill. A breeding experiment with the fruitfly *Drosophila* provides a good example (Figure 2.1). It is not performed in the school laboratory because of the limitations (mentioned above)



```
GENE

How many genes (1-4) ¬2

What are the symbols:
   Gene 1¬bw
   Gene 2?vg

MALE parent GENOTYPE
   Gene bw ?BwBw
   Gene vg ?Vg Vg
FEMALE parent GENOTYPE
   Gene bw ¬bwbw
   Gene vg ¬Vgvg

How many offspring ¬6

Offspring

No.SEX EYES   WINGS

3   M  red    wild
4   M  red    wild
5   F  red    wild
6   M  red    wild
7   M  red    wild
8   F  red    wild
```

(a)

```
GENE

How many genes (1-4) ¬2

What are the symbols:
   Gene 1¬bw
   Gene 2¬vg

MALE parent GENOTYPE
   Gene bw ¬BwBw
   Gene vg ¬VgVg
FEMALE parent GENOTYPE
   Gene bw ¬bwbw
   Gene vg ¬Vgvg

How many offspring ¬6

Offspring

No.SEX EYES   WINGS

3   M  red    wild
4   M  red    wild
5   F  red    wild
6   F  red    wild
7   F  red    wild
8   F  red    wild
```

(b)

Figure 2.1 Two computer simulated experiments with *Drosophila* involving two mutant genes ---**bw** for brown eyes and **vg** for vestigial wings The genotype of the male and that of the female parents with respect to genes for eye colour and wings are specified by the 'experimenter' who studies the sex ratio, eye colour and the nature of wings among a present number of offspring in two different experiments, (a) and (b)

imposed on the schools by available resources. Limitation of time does not allow an experiment such as this to be conducted in the school lab. Trial and error method of experimentation takes time which the school time-table does not permit. Lab space, at the same time, imposes another constraint. It would be expecting too much from the modest school labs to provide adequate space for breeding *Drosophila* for different genetic studies. The cost involved in performing laboratory experiments is often prohibitive. Laboratory apparatus and chemicals are rather costly for the school system. Expenditures on these are recurring in nature. There are many experiments in which manipulative skills of performing the experiments are less important an outcome than understanding of scientific principles behind the experiment. On the other hand, the teacher has little practical experience of conducting certain tasks, e.g. avoiding air bubbles in the xylem of a plant when setting up potometers or sexing *Drosophila* when setting up breeding experiments.

The micro provides a possible alternative which, through simulations and models, help you overcome some of these constraints.

Difficult or abstract concepts can be simulated and the student invited to alter variables and see its effects on the system under study (Figure 2 2,2 3,2.4).

The main advantage of using a good simulation program is that a large number of variables can be controlled and manipulated by pupils, the performance of pupils can be monitored unobtrusively, without interruption. The dynamic nature of simulation and the excitement it provides retains attention, interest and involvement of the user. The computer can handle more complex areas of knowledge and reach a closer match to reality than is otherwise possible. This enhances the scope of learning.

On the other hand, some computer-based simulations are badly constructed They are deliberate oversimplification of processes which are not fully understood, or are simplified in the belief that this makes them easier for children to understand. As a result of this, simulations of social, economic and historical scenarios often represent 'an overly mechanistic view of what society is like', leading to mechanical activities.

Information handling, display and demonstration are also valid uses (Figure 2 5). In many cases, the micro can analyze results obtained by experiments or help perform actual

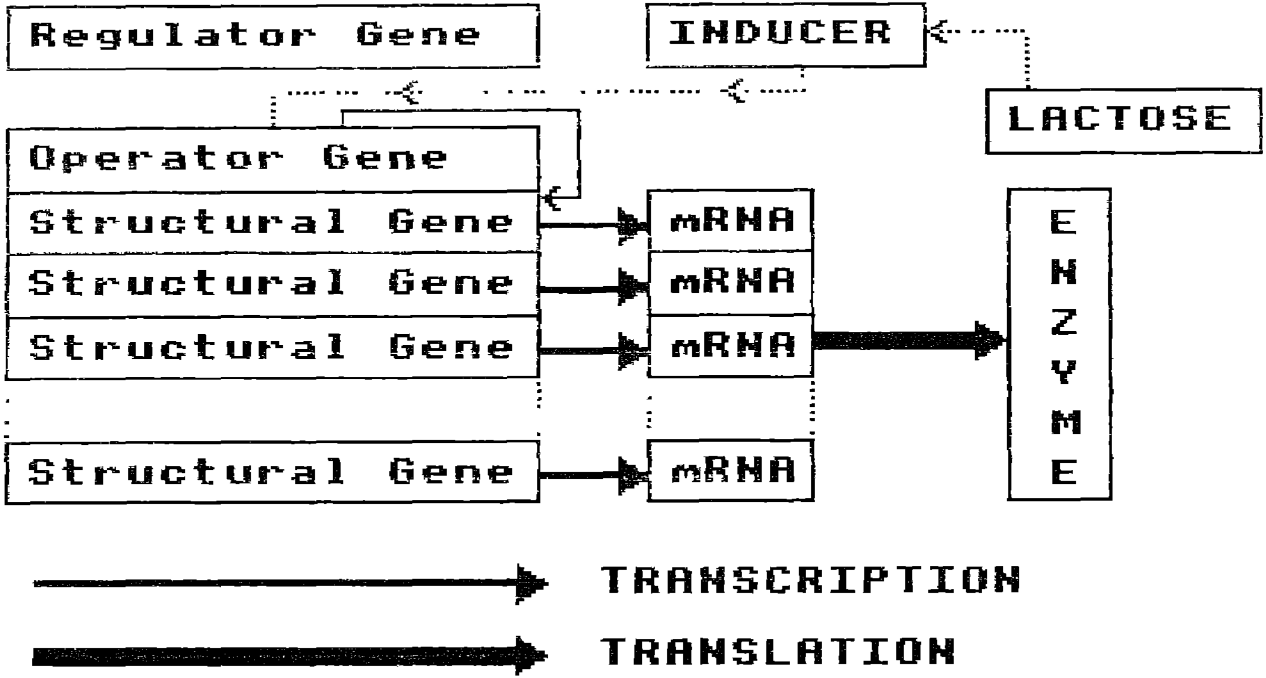
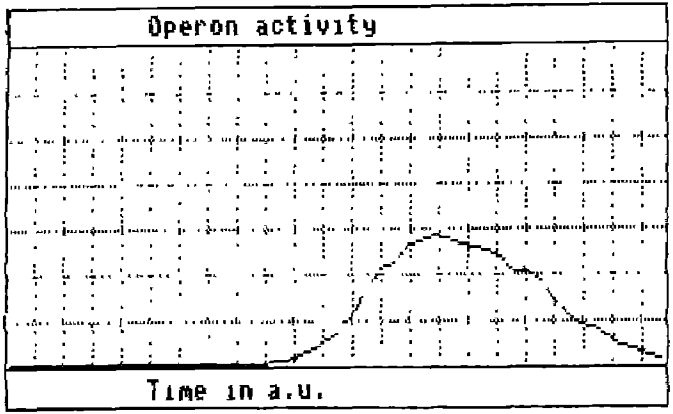


Figure 2 2 A simplified flowchart of the operon system in *E coli* illustrating on screen the complex interrelationship involved.



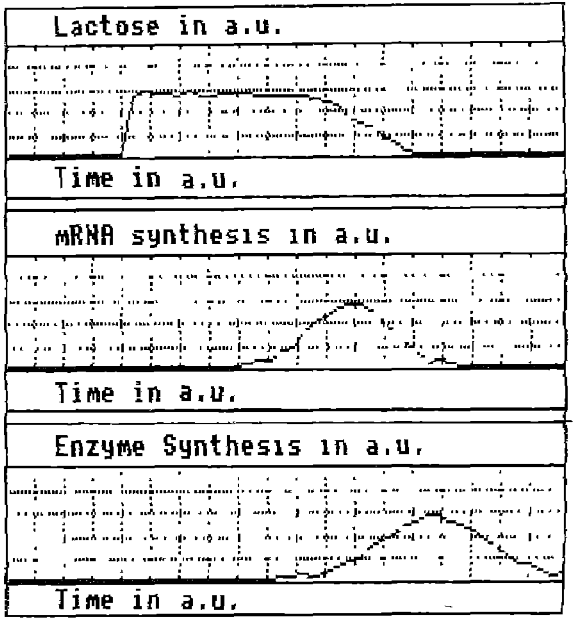


Figure 2 3 Computer simulation of sequence of events showing operon activity in *E. coli* triggered off by the presence of lactose. The quantities of lactose in the culture medium (user controlled), mRNA and enzymes are expressed in arbitrary unit (a u) as are lengths of times for mRNA and protein synthesis

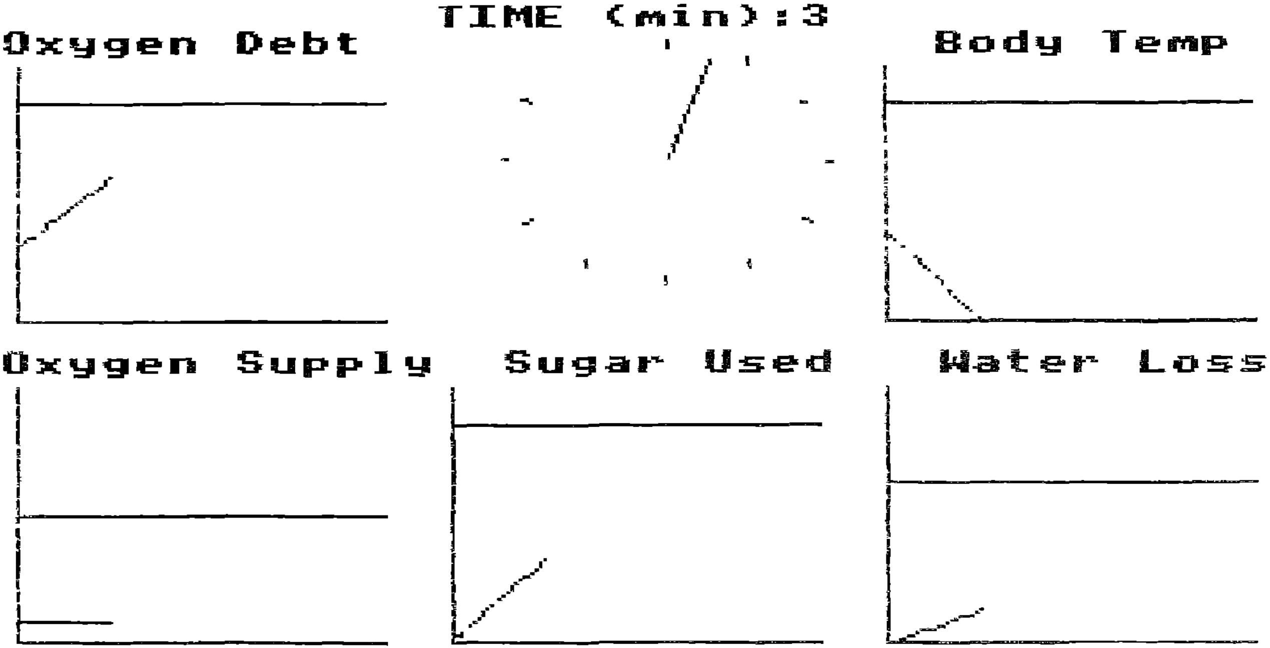
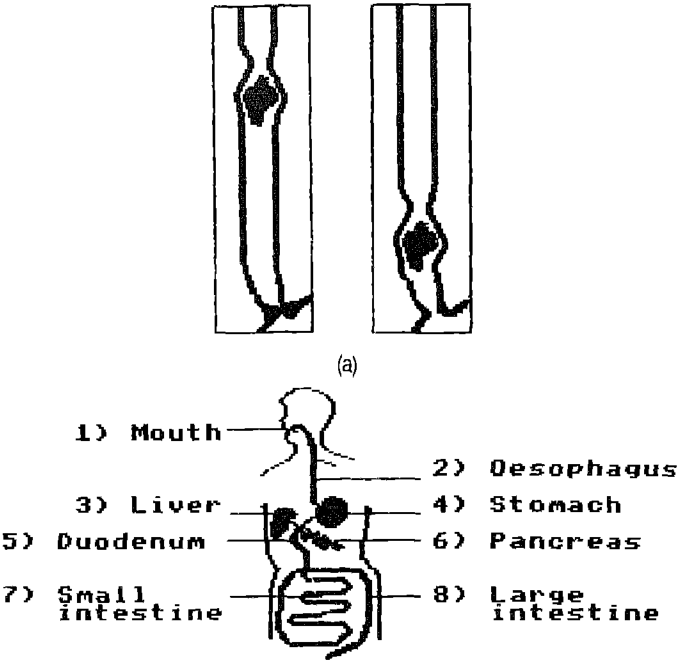


Figure 2 4 Physiological simulation on the microcomputer The user sets values for breathing rate, breath volume and sweating rate of an individual for a particular activity

This screen shows dynamic graphs of five variables plotted against time telling you about the conditions in the body of the individual



(a)

(b)

Figure 2 5 The microcomputer graphic display has an overriding advantage—it can be interactive The user zooms in on one of the organs—the oesophagus in this case (a) to show how the ingested food moves down the tube, (b) a general screen display of alimentary organs of man

experiments through interfaces

While using the micro with appropriate software, however, you ought to remember that you have a different role to play compared to your traditional role and adopt different techniques with respect to different programs Your role becomes supportive and suggestive rather than directive and prescriptive Teacher-pupil *interactions* become more important Micros offer opportunities to learn in different ways and different things. The learning potential becomes much more open-ended and it is often difficult to set out clear aims and intentions You can be responsible and adaptable, exploring and learning with the pupils

For Additional Reading

1. *The Use and Misuse of Computers in Education*
   by Alan Ellis McGraw-Hill 1974
2. *Computer Assisted Learning in Science Education*
   Edited by Graham Buch. Pergamon 1978
3. *New Information Technology in Education*
   by David Hawkridge. Croom Helm 1983
4. *Computer-based Learning*
   Edited by N.J. Rushby. Pergamon 1983
5. *Young Learners and the Microcomputer*
   by Daniel Chandler
   Open University 1984
6. *New Horizons in Educational Computing*
   by Masoud Yazdani. Ellis Horwood 1984
7. *Microcomputers and Teaching Biology*
   by Sophie McCormick Longman 1984
8. *Cohabiting with Computers*
   Edited by Joseph Traub William Kaufman Inc 1985
9. *Communicative Language Learning and the Microcomputer*
   The British Council Publication 1986
10. *Computers . Promise and Challenge in Education*
   by David Woodhouse and Anne McDougall
   Blackwell Scientific Publications 1986

In the Classroom

The intellectual climate that gave rise to the first generation of computer-assisted instruction (CAI) in the early sixties was strongly influenced by the programmed instruction (PI) movement. CAI was seen as a direct continuation of the mechanical teaching devices. But PI and drill have not flourished as universal technology of instruction; they have rather limited domain of application. They enforce on the learner a particular sequence of action as though the computer is meant to 'program' the user. The learner usually resents this control.

The Range of Application Today

With the rich abundance of imaginative software, the computer provides a supplementary teaching aid which is extremely versatile. Most educational computing projects use different types of prepared programs and suites designed sometimes by teachers and those that are available commercially. In using such prepared programs, no special knowledge of computers or programming is necessary The computer's ability to link with other delivery vehicles, such as interactive video systems, enables it, with the help of necessary software, to exploit systems and devices totally outside the possible range of traditional classroom and laboratory equipment.

Most of the programs that are used are interactive to varying degrees, adaptable for teachers and pupils and can be used with a variety of different teaching styles.

The widespread availability of micros since 1980 has unleashed a remarkable amount of creativity through programs that allow a variety of possible user inputs, i e. branching programs that accept inputs at each point. A somewhat lengthy sentence, which was originally penned to describe the role of computers in language learning but aptly described the state of the CAL (Computer-Assisted Learning) art, reads like this (a)It is possible to make relevant use of computers to help create exciting learning environments in which (b) the limitations of the technology becomes less problematic because (c) a more appropriate role of the hardware has been found through (d) the design of imaginative software (e) which is better attuned to current views of ... learning.

Most of these programs capture, collate, calculate or display data, simulate and model, present educational games and permit a variety of other activities

Collation and Calculation

Because the computer can compute, it can be meaningfully used to analyse and represent collated data or results of class activities in the form of table, graph, histogram or pie chart. There is readymade software that helps do this exercise There are programs which permit statistical analysis of data and display the results in various ways The final display can be interactive, which is an added advantage over static display through overhead transparencies. Many facts and concepts pertaining to various school subjects revolve round figures and arithmetic and involve time-consuming calculations Built-in facilities available with many topic-oriented programs perform these calculations allowing pupils to concentrate more on the topic and the ideas inherent in it rather than getting entangled with calculations

Data Caputre

Senior school students of science have one application of micros that is peculiar to their chosen discipline — employing the microcomputer for direct collection of reusIts during science experiments, processing of results and deriving a particular scientific principle Interfacing the micro with suitable devices, and with the help of appropriate software, one can measure quantities hitherto unmeasurable in the classroom environment, e g. acceleration, or record and display readings of light, pH, etc. directly and automatically There are advantages in this process First, if the conditions are controlled and devices are of high enough quality, the readings will be more accurate than those that are obtained through human measurement Secondly, more time can be devoted to the all important job of analyzing results. Thirdly, many experiments can be carried out which it is not possible to do in the traditional high school laboratory Finally, in some cases, it may be helpful for handicapped pupils who are unable to manipulate the elaborate laboratory apparatus

Simulations

Covering practically all school subjects, computer simulations have a large variety to choose from

There are occasions when, for a variety of reasons, e g cost, danger, speed, size, time, etc , a process cannot be experienced or demonstrated in the classroom The computer software is ideal for providing simulations as a way of extending the range of investigations into social, historical and commercial processes, as well as those of industrial, physical, chemical and biological nature

However, simulation programs available in the market are mostly related to science subjects, e g study of inheritance of characteristics in the fruitfly, investigation on relationships between scientific principles and economic and technological constraints that characterize large-scale industrial processes, ecological concepts such as the competition between organisms for resources In fact, there is no dearth of programs Some are slight, others weighty with academic pedigree You have only to be sure which are the ones that meet the requirements of your school best

The motivational qualities of a simulation can be significantly improved by turning it into a game. The question is. How best to exploit the students' interest and enjoyment for educational purposes? With young children playing the games, the ideal approach is to play with groups of children, each group having a particular role to play The role of the teacher would be to supervise these groups, but allowing children to work out their own strategies

The use of a simulation program in the classroom is not exactly teaching It is learning by students — the participants or characters of a role-play — who use given facts to learn new facts and discover new relationships The role of the teacher is that of a controller, arbitrator, consultant or umpire who does not interfere with what the students are doing, for learning is placed in jeopardy by interference The teacher should, mainly, observe what is going on, without appearing to do so, giving brief guidance now and then so that the activities do not go astray. Pupils or groups of pupils will be thinking, talking and making decisions, comparing notes and learning from each other as well as from the program.

Successful use of simulation requires three distinct activities — briefing, action and debriefing Briefing is a practical session — a short discussion of the checklist of items to be dealt with, points to be made and queries answered The action session comprises what pupils actually do with the simulation program—learn strategies, decision-making, problem-solving, the use of language and the art of communication and, of couse, facts Debriefing takes place during the follow-up session when the controller resumes the traditional role of the teacher and leads the discussion on various aspects of the simulation, moves from the specific to more general, avoiding a re-run of the arguments De-briefing is not an optional session, it should be taken as an integral part of the entire learning exercise.

Modelling

In some school subjects, certainly most commonly in science, students design and develop models. Often these are mathematical models. Computer programs can be used to examine these models, to modify them, if necessary, and see if they work in the predicted manner. This requires some knowledge of programming, however

Well, those were some of the different kinds of computer programs commonly used for teaching and learning of various school subjects There are many other possibilities—ranging from the use of software in control technology, e g controlling devices such as cranes, robots and vehicles, to the use of hypertext software which simulates the thinking process, allowing one to glide between varying ideas by combining pictures, written matter, music and graphics There are other innovations which are capable of making remarkable contribution to the teaching and learning of art, crafts and music.

Simulation, modelling and problem-solving software is meant to make the user think and reflect upon the presented material The more challenging and imaginative the program presentation is, the more effort the pupil is required to make to explore what the software offers This contrasts sharply with the more passive role in reading a book or attending a lecture

Suggested Activities

1 Run all available educational programs and note their unique characteristics.
2 Prepare lesson plans and suggest pupils' activities with respect to each program
3 Jot down teaching points in each program
4. Suggest curriculum-related activities with each available open-ended program

MODULE 3 : AUTHORING AN INSTRUCTIONAL PROGRAM

Aims of this module:

1 to expose you to the possibilities of becoming an author yourself and creating courseware according to your needs

2. to make you realize that with the evolution of more user-friendly systems, you can use the machine more easily than you thought

3. to enable you to author a lesson

Objectives of this module. Having done the activities indicated in this module, you should be able to :

1. use a courseware authored by someone else
2 create a meaningful lesson in your own area of teaching.

Authoring an Instructional Program

Desirable criteria for useful educational programs are that they should be relevant to the educational situation in which they are used and that they should not be restricted to repitition of a single activity based on an unchanging content One way in which these criteria are met is through the provision of an authoring program.

An authoring program capitalizes upon the fact that many modern programming languages allow a clear distinction to be made between the program of instructions fed to the computer and the data upon which the instructions operate It is thus possible to alter data without affecting the instructions

An authoring program allows the user in a straight forward non-technical manner to create a lesson It is not necessary to know programming or indeed the internal details of how the lesson is organized in the electronic medium For example, a lesson on organic evolution can be based on data provided by the author (teacher) rather than being restricted to what was once incorporated in the softweare by a programmer who had little knowledge of what the lesson was meant for.

This is a powerful facility. First, it means that you can customize a given program to the syllabus that is being followed and to the level of proficiency of the students Secondly, students can be encouraged to use the authoring program themselves. Finally, through the use of an authoring program, a large bank of material can be created for others to share.

For successful use of an authoring program, however you have to be capable of making strategic decisions . *What* is to be communicated, to *whom* and *how* ?

For Additional Reading

1 Computer-assisted Instruction A book of readings Edited by R C Atkinson and H A Wilson. Academic Press 1969

2 *Software for Educational Computing : A general purpose driver for computer-assisted instruction interrogation, and system simulation*
by K. Ahmed and others. MTP Press 1980

3. *Selected Readings in Computer-based Learning*
Edited by Nick Rushby. Kogan Page 1981

4. *CAI Sourcebook*
by Robert L. Burke.
Prentice-Hall 1982

5 *Computer-assisted Instruction : Its use in the classroom*
by Jack Chambers and Jerry Sprecher
Prentice-Hall 1983

6. *Introducing CAL : A practical guide to writing computer-assisted learning programs*
by Keith Hudson Chapman and Hall 1984

7 *CAL/CBT . The great debate*
by David Marshall
Chartwell-Bratt 1988.

Using An Authoring Program

Writing a computer courseware is different from writing a one-act play. But at the same time, writing courseware is similar to planning any act of communication. You have to make some strategic decisions.

What do you want to commiunicate through your lesson? What concepts, techniques or results? Something easy or difficult? Routine or demanding creativity? Subjective or objective? Snippets of information or the skill for making sense out of those fragments? A statement of facts or a means of discovering them? Who is your audience? The most advanced student? The slowest? Both? Do you want to know about the students' activities as they are interacting with your lesson? The decisions are important for finding an efficient match between the topic, the student and the manner in which you treat your subject. To start with, these decisions should be independent of the medium to be used for delivering the lesson you have in mind.

Once you have decided on your topic, the medium begins to enter into consideration How do you present these ideas to your audience, making the best use of your medium? Your manner of presentation depends on the nature of your audience. Picture your typical student and ask yourself *What would I do if I had to explain the topic to this student?* Well, you can talk, scribble and erase on blackboard or paper, or ask questions. When you ask questions, i.e. when the monologue is about to turn to a dialogue, you tend to anticipate the students' possible responses to your questions.

It is at this point that the limitation of what you can do with your courseware shows up starkly However interactive you think your medium is, you have to abandon your favourite questions : *Why do you think this happens? What would go wrong if we did it that way? Can you formulate a general rule that covers these examples? There is an error in the argument - can you tell me what it is?* There is hardly ever a chance that your program could give an adequate response to the students' answers. Of course you can pose general rhetorical questions which are then answered by your program ignoring the genuine response of the student. But that is playing trick with yourself. It is not necessary that you must ask questions; you can be more subtle by being straight forward. When your student responds to what your program offers, and your program 'talks back', there is a dialogue.

There are a number of things that we can learn from other media and apply while designing courseware. A table of contents and an index help the reader find his way through a book, so he can browse as well as read from beginning to end. These elementary facilities must be discovered by the author of an instructional dialogue

The Design Much of courseware design is related to aesthetics. And the computer community apparently needs to learn that aesthetics is related to understandability

The design should promote the learning activities envisaged by you. Therefore, it is necessary that the screen design is considered right from the start of the development of your courseware.

The student often needs to see a certain collection of items together or it will be difficult for him to see a 'whole picture'. Can the whole screen be changed instantaneously ? If so, one can attempt fast animations; if not, you are going to bore the user with long-lasting displays that carry little information.

The monitor screen is a finite space. The user should find it easy to sort out the different types of information usually present on the crowded screen at the same time, including logistics information such as an indication of where in the lesson the user is, what he is supposed to be doing there and how to get help if he needs it Background information or reminders that the student might need to solve his problem (e g. force = mass × acceleration) and his last input, if it is relevant to the current topic—each of these should be consistently written in the same area of the screen, so that the user knows immediately where to look for the information he wants. Elementary rules of style must be observed when using the computer driven screen Your most brilliant design comes to naught if the user stumbles over minor difficulties at every step.

It is only natural that what you want to convey, i e. the educational content, determines the information that you want to display Your courseware may present factual information to be remembered, translate abstract ideas into concrete terms, or provide an experience which encourages discovery and decision-making. The type of activity influences the kind of display. The learning environment in which the courseware is likely to be used is an important factor You cannot have a crowded screen with minute display items and great many details for a program that is meant for large group use where the whole class watches the display on one TV screen. The nature and the purpose of the program should determine the degree of complexity of screen display But display the minimum amount of information necessary to achieve your purpose This means you can do two things use more graphics rather than text, where possible, but keeping graphics simple, and you can also reduce the amount of text using the language more effectively

But there are occasions when you might intend to show how complicated something is In such cases, you cannot avoid a complicated display An elaborate screen display which is built up gradually, bit by bit, ends up looking complicated. But still it is comprehensible because of the way in which it is built

If you think your student must be given a shipload of textual information, consider the choice of calling up that information at the user's will

Changes to the display resulting from a user-input should be clearly visible They should be completed at a speed that allows the user to take note of Ideally, the speed should be user-dependent Reading ability within a single group of students varies considerably, making it essential that changes to text displays be user-controlled. Even an animated display can be stopped and continued at any stage to assimilate the changes which occur

A dynamic page (i.e a screenful of information) serves as a useful organizational unit of a courseware. When it is necessary to replace a page, clear it all and then display the new page. The current input and output should not be appended to the solid block of previous discourse, or to the debris left by it.

A page should not suddenly disappear There should be a well-defined moment when a page appears on the screen, and one when it disappears, replaced by another page Better still, a conscious action on the user's part should be necessary to turn a page Each page should have a name or a number. This name should be displayed in a corner of the screen for the entire duration of display

Colour and Graphics

Select colours which are in good contrasts But do not let colour distract. Colours give good visual clues by adding information to a display without taking up additional space on the screen (although colour requires a lot of space in the computer's memory). Elements of a display which appear in the same colour are often expected to suggest relatedness. So try to be consistent with the use of colour throughout a program You can avoid incorrect associations being made by limiting the number of colours used

Text is verbose On the other hand, the graphics screen can use the elements of time and animation to express many ideas compactly and unambiguously A picture is often more readily understood than a paragraph of text is You can effectively divide the screen into windows, one window showing graphics and another the text at the same time Each window can be planned as a subscreen

Animated graphics can be very effectively used for simulation or to show changes within a process. But if misapplied, as they often are, moving images can distract the eye.

The Text

Seldom does the courseware developer pay much attention to the quality and quantity of the text that is displayed; we see badly written textbooks on the screen. But monitors are not for displaying textbooks, even if they are well written.

Solid chunk of illuminated text on a dark screen reduces readability Moreover, if you are not using a very sophisticated system, you cannot have proportional sapcing of characters, unrestricted line spacing, a choice of type faces or sizes and the liberty of precise placing of text on the screen. So economize on the text

Do not scroll or scramble your text The text which scrolls off the top of the screen while new text appears at the bottom is distracting The old text should be cleared to make room for the new

Line breaks are important for reading and comprehension Some words go together, like verb forms - 'to imagine', 'to decide', or prepositional phrases - 'in case', 'of course', 'at all' Meaning of these word groups derives from reading all words in a group together. Therefore these word groups should appear on the screen together. Our TV newsreaders, who read aloud from the text that is displayed on a teleprompt screen, sometimes display the result of splitting similar word groups and reading them as separate words with a fumbled pause between.

Nothing is so forbidden as hyphenation at the end of a line Be it on a printed paper or on a TV screen, 'the-' at the end of one line and 'rapist' at the beginning of the next would confuse the reader Mixing participial phrases with infinitive phrases, nouns with imperative sentences and phrases with clauses should be meticulously avoided

Where From, Where To !

Having spent a while with your courseware, your student is going to ask. *Where am I? What can I do here ? How did I get here? Where else can I go? How do I go there?*

A well-structured dialogue must provide conveniently available answers to these frequently asked questions.

The name or number given to each dynamic page provides answer to *'Where am I?'. 'What can I do here?'* should be answered by displaying list of all commands at the moment of enquiry

There could be a particular set of commands that must be active at all times -- the motion commands These commands allow the user to leave a page and move to any other page in the lesson With a complete set of motion commands, the questions *'Where else can I go?'* and *'How do I get there?'* can be answered, since the same motion commands apply throughout the system and they always have the same effect.

There remains the question *'How did I get there?'* which occurs when the user has mistyped or misunderstood a command The system should store a part of the user's trail as he is interacting with it-- at least as much as would be necessary to return to the previous page

Much of the problems related to *'Where from have I come and where shall I go?'* can be overcome if your courseware accompanies a printed drive chart, which is a simple diagram designed to show the way in which the user can control a program and also summarizes what a program does Drive charts show the various decision points in the program, the choices that can be selected at these points and the interconnections between them They provide a secure user image of the program.

The PI Hangover

If you are planning to use an authoring program, chances are nine out of ten that you would be tempted to design lessons for programmed instruction (PI) With character strings or numbers as input and static frames as output, an authoring program would be a reasonable tool for PI.

However, PI and drill are not universal technology of instruction, they have a limited domain of application If you succumb to the temptation of writing a PI, you are likely to be unable to overcome the PI legacy of excessive control of the student's movement through the presented material. PI rigidly enforces on the student a predetermined sequence of action; it programs the student

The student resents this control Why does he resent is irrelevant You have lost that student.

Reward or reinforcement for giving correct answers is another common tendency But more often the reinforcement is shallow, if not cheap

A number of authoring programs encourage teachers to collect data about the student's behaviour. How much time he has logged (not how much time he was paying attention), how many questions he has answered right or wrong (not whether he actually tried to solve the problem or was merely guessing) and how long it took him to answer a question (not how long he had been thinking) seem to be important Often these data are of no use Data about elapsed time are of little interest except in drill where speed is an explicit goal Thoughts wander off The clock does not show how much time is deployed to the task that was posed. Perhaps people think that this data collecting feature makes a program look smart. I think a dumb program is a smarter move.

On the other hand, data that tell the teacher if he has correctly anticipated the user's state of mind are indeed useful But if the teacher attempts to diagnose the student's thought process through the answer, he should collect actual student answers, and, if possible, interview some students to verify that the relationship between reasoning and the answer is what he expects it to be

Giving the student a convenient opportunity to make comments at the moment when something is puzzling him, without having to exit from the lesson, is the most important contribution to data collection that a program can provide.

Suggested Activites

1. Get acquainted with an authoring program.
2 Use an authoring program to create a lesson in your own area of specialization, using all available features of the software
3. Use in the classroom a courseware you have authored.

MODULE 4 : USING A DbMS

Aims of this module:

1. to introduce information handling as an essential skill
2. to introduce basic features of a DbMS
3. to illustrate that DbMS can be used in a wide range of situations within the existing curriculum.

Objectives of this module Having done the activities indicated in this module, you should be able to ·

1 define the following terms.
   data capture (obtaining the data)
   data input (entering it into the system)
   organization (storing data efficiently)
   storage (retaining the data)
   search and retrieval (finding desired items)
   presentation (making it meaningful)
2. use a given database program to bring out information
3 make a short file of your own.

Using a DbMS

In common parlance the term database is restricted to computerized data But in fact anything from, say, a list of tall, dark, handsome and wealthy bachelors in town to that of video cassettes pirated every year, is a collection of data And that is what a database is — a collection of data

A suite of computer programs that deal with input, storage, output, etc is called a Database Management System (DbMS) The features of a DbMS depend on what it is designed for But all database programs have some common characteristics : they accept data, organize its storage and provide means of retrieving it A considerable refinement is usually added to these . selective retrieval, comparisons, updates and so on

Before using a database program, we should talk about data/information itself (for the sake of convenience, *data* and *information* are used here interchangeably, although they are not synonymous) Information is usually organized into *files* A file is made up of *records* The number of records is variable A record is made up of *fields* If we take the list of bachelors as an example of a file, then each record will be the information about a particular bachelor The individual pieces of information such as name, phone number, age, height, complexion, bank balance, etc. are fields. A field is made up of characters which may be letters, digits or special characters such as spaces, asterisks, etc If all information on these people are arranged in a tabular form, then each horizontal row will be a record of an individual and each vertical column will represent a field The entire table would be the file

The question, however, is *Where do you use a database?* Well, anywhere except under water! The use of a database is restricted only by the user's imagination. It can be used where information is being collected and collated from a number of sources, as it often happens in the sciences, humanities and social sciences (Figure 4 1) It can be used to

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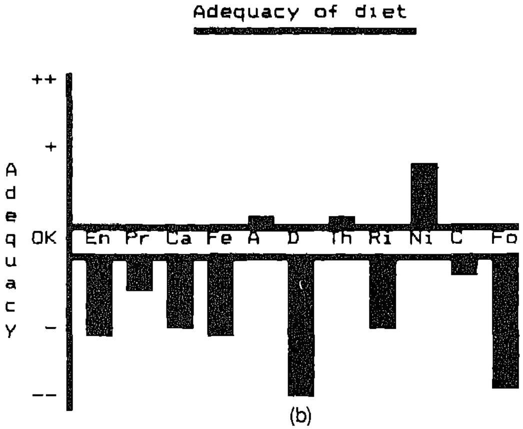
                    DAILY REQUIREMENTS
                    ------------------
                       REC.    AVE.
                       DAILY   DAILY   ADEQUACY
                       INTAKE  INTAKE

Enrgy    kJ              8569    4684        -
Prot     g                 51      44       OK
Calcm    mg               700     416        -
Iron     mg              12.0     6.7        -
Vit A    ug               570     570       OK
Vit D    ug              10.0     1.5        -
Thiam    mg                .8      .8       OK
Ribof    mg               1.2      .7        -
Nicot    mg                14      19        +
Vit C    mg                25      24       OK
Folic    ug               300     577        -

              People: 1   Days: 1
                 Group(s): 24
```

(a)


Adequacy of diet

(b)

Figure 4 1 Instant retrieval of desired pieces of information from a vast collection of data, and their comparison, are significant advantages provided by a database Here the table (a) and the bar diagram (b) are selective outputs from a database on dietary requirements, they provide a comparison of the nutrient intake from a given list of foods (not shown here) with the recommended daily intake for an individual based on sex and occupation Group 24 in (a) is the code for a female in the age-group 9-12 store results from practical investigations in geography, environmental sciences and the more traditional sciences. An awful lot of peripheral learning takes places while using a database.

Handling data on a variety of media from different sources has always been an integral part of learning. Children now have the opportunity to use information handling programs (DbMS) that support the existing curriculum and open up new possibilities for self-directed enquiry. There is a marked trend, however, that an attempt to teach "information skills", like the ones that a database system encourages, might produce users of information but with increasingly little use for it. This is so primarily because there is no natural link between the curriculum that is practised and "information skill" that imparted.

I hope this module would help you find a natural link.

For Additional Reading

1. *Database in the Classroom*
   by Derrik Daines Castle House 1984
2. *Learning with Computers*
   by Suman Bhattacharjea and Anant Kartik Mithal.
   A.H Wheeler 1987

Teaching with Database

Databases allow students to cope with the ever increasing volume of information available on any topic they study. But being able to handle more data, in itself, is not a major educational advantage. It is the quality of what students are able to do with the data which is important. The skills of finding and interpreting information are an important outcome of education. Database means that the information can be retrieved in many different ways, allowing cross-comparisons, re-ordering and re-arrangements that would be far more difficult to achieve by hand In essence, databases help in :

- Analyzing relationships for example, is there a relationship between the age and the cause of death of people in India ?
- Identifying trends : for example, trace the patterns of change in birth rates in India during the past 40 years and relate those trends to other demographic factors.
- Discovering similarities and differences among groups of things or events : for example, what are common properties of mushrooms.
- Keeping lists up to date . for example, keeping a growing list of the fauna or flora of a region.
- Organizing and sharing information : for example, putting the results of library or field research on a data file about migratory birds that visit different sanctuaries in India from afar every winter This can then be added to by other students so that there is one organized collection of data that can be used by all students.
- Arranging information in more useful ways : for example, a file of data about a whole bunch of macromolecules, their essential properties, etc.

One of the important uses of databases is to promote development of inquiry skills, these, in turn, promote independent learning as students are involved in the stages of data processing, data analysis and drawing conclusions.

A database can be used to help students comprehend overall trends while still retaining an understanding of specific instances. The level and form of the shifts from the general to the specific and vice versa can be controlled directly by the student. Most importantly, it is he who decides how the information is to be organized and shaped to fit with his question and purposes. If you use it carefully, a database will encourage pupils not only to identify possible trends and relationships, but just as importantly, it will make them decide upon ways of putting their hypothesis to the test.

Database activities can promote a range of other skills dealing with information. The use of databases involves students in the process associated with information handling, rather than just with the content of a subject or a topic But for any meaningful activity, initial thoughts are to be broken down and plans for extracting the information relevant to the hypothesis worked out This 'learning how to learn' is best achieved through a cooperative group effort rather than individually Such group work develops social interaction skills as several students work together to achieve their goal The computer activity then becomes subservient to the interchange of ideas amongst student groups Database constructing activities are a unique cognitive experience of which computing experience is a part

Much of the value in using a database program lies in the process preceding and following the actual retrieval of data Structuring relevant questions, predicting relationships and analyzing the requirement are important activities where collective efforts of groups of pupils create an atmosphere for learning.

It is important that you ensure group discussions and analysis before and after the actual use of database programs, the process of work is as important as the result of work All work with databases does not occur at the computer Introduction to the area in which the program is to be used, planning and sharing of results take place away from the computer. All valuable experience is not necessarily 'hands-on' (nor is all hands-on experience necessarily valuable). You really do not need a large number of machines and large blocks of lesson time in the computer room.

Learning takes place when one collects information — be it through observation, library research or laboratory experiment, decides how the collected information is to be organized to fit with one's purposes, and further, when one analyzes the information and draws conclusion. The computer plays the crucial role in processing what is put into it and in retrieving the desired output, but the role is not central to the database constructing activities

Let us now see some practical aspects of making a database

Beware ! There are lots of traps for the unwary — hidden and unhidden! You have to be careful about .

the type of computer you use
the database program you use
collection of information
entering the information
protection of data

The Type of Computer

Apart from the operation of database, there are physical factors to be considered If the program that you are going to use is memory dependent (i e the entire program is contained in the computer's memory at one time), the memory size of the machine has to be taken into consideration If the program is disk-based, you will need to look at the size and speed of your disk drive Make sure you fit all the data you want into your database using your computer and the program

Here is a rule of thumb for calculating the number of records that you can fit into memory or on disk Add up the maximum possible number of characters in every field Add 1 for each field. Divide the space (in K) available in the memory or the disk by the number you have got For example, your database may have the following fields

Name	*Longest 20 characters*
Age	*2 characters*
Sex	*1 character*
Occupation	*19 characters*
Marital status	*9 characters*

So the sum of the maximum number of characters in a record will be 20 + 2 + 1 + 19 + 9 = 51 Add 5 to this because there are five fields Now the total number is 56 The memory based program that you have leaves, say, 55K-bytes free space for the user The maximum number of records that your system will permit is 55000/56, i e nearly a thousand

This is a rough guide, suggesting the limit to the size of your file

Database Specifications

In certain cases you might have to split your database if you want to enter more records than your program permits This is possible only when comparative records between different parts of the database are not necessary.

Collecting the Data

Accuracy is important in data collection Students can collect data in groups. You might have one reading the data, one recording it and one checking if it is correct

Entering the Data

Data entry should be done meticulously to maintain uniformity MALLIK and Mallik may appear to be same to you, but the computer is likely to read them differently Establish also a set of rules about spacing, commas and any other special marks you will use

Protection of Data

Ask your students to keep back-up copies as they construct their database

Here is a step-by-step worked out example of construction of a database of trees found in a particular area

Assess the size of the database We must know the number of records to be stored 96 species of trees, say, have been found in the area

Assess the number of fields per record We have decided that we would need the following fields: Common name, Botanical name, Genus, Average height (m), Flower colour, and Seed (6 fields)

Assess the length of the longest fields in each case. These are

Common name	*Simal (5)*
Botanical name	*Salmalia malabaricum (19)*
Genus	*Salmalia (8)*
Av height (m)	*12 (2)*
Flower colour	*Red (3)*
Seed	*Dispersal by wind (15)*

The numbers written next to each field give the number of characters Thus 52 + 6 (1 for each field) = 58 characters *Calculate the required disk storage or memory.*

96 records × 58 characters = 5568 bytes.

Check if the school's computer/DbMS program permit this Let's assume that with the computer and the DbMS available in the school, it is possible to make our database 'Trees' would be a suitable name for the database. Field names specified above are to be used Entries are to be made in upper and lower case One space between words No commas or full stops

Do some imaginary sorts to make sure you have covered everything We prepare some sorts and searches and check if we have included everything

* *Establish database.* We enter the structure into the computer (name, fields and other details). We have already collected and verified data

* *Enter data.* A group of students enters data, another group checks if the entry is correct

* *Make sure that data entered agrees with collected data* Use printouts to check data against survey report

Out of a number of steps listed above, it is only at three (with stars) where we need the computer and that too for groups of students, not for individuals So the oft-repeated arguments that computer-based activities in schools are restricted by the limited number of computers or lack of time to spend on such activities and the like are far from convincing

The choice of a Database Management System depends mainly on whether the program I go for is able to carry out the task that I have in mind. Some characteristics to look for when choosing a program are

* Easy to learn Manipulation of the program should be technically simple so that the user feels at ease while managing his information. A brief orientation should be enough for students to be able to begin retrieving information from a file.

* Easy to use Students should not have to memorize a lot of computer commands or wade through complicated menus

* Flexible format for data The program should not prevent you from experimenting with different kinds of data files for different purposes.

* Files of manageable size Given the limitations of storage capacity of the disk, a file should be able to contain all the information that students want to enter If you want your files to contain a lot of text, choose a program which will give you the storage capacity you need

* Ease of manipulation and retrieval Students need to be able to easily retrieve from the file a particular piece of information or a collection of information that meets the specified criteria.

* Control over the way the information is presented. Students should be able to print the selected information in any form, like a graph, chart, table or list, sorted alphabetically or numerically

Suggested Activities

1 Get familiar with a database already prepared by your instructor using a DbMS
2 Retrieve desired information from the prepared database (or datafile).
3. Create a database of your own using a DbMS
4. Retrieve various combinations of information making meaningful queries

MODULE 5: SPREADSHEETS FOR SIMULATION

Aims of the module	1	to introduce you to a spreadsheet
	2	give you the basic capabilities to construct simple spreadsheet models on curricular areas

Objectives of this module. Having done the activities indicated in this module, you should be able to

1. construct models using a framework in which formulae are already provided
2. construct models on your own entering headings, data and formulae
3. perform what-if analysis of problems in your area of specialization, using a spreadsheet program

Spreadsheets for Simulation

Spreadsheet was one of the first pieces of powerful application software

To understand the principles behind a spreadsheet program, imagine a huge sheet of paper marked out into squares by a large number of columns running vertically and rows running horizontally

Any one of the squares, normally known as cells, boxes or slots, thus created, can be uniquely identified by giving a reference to the column and row in which it lies

Normally the columns are referred to by letters, the leftmost column being denoted as column A, the one on its right being column B and so on all the way to Z After the twentysixth column, they may be referred to by combinations of letters such as AA, AB, AC, BA, BB, BC, etc. Rows are referred to by numbers from 1 at the top, followed by row 2, then row 3 and so on

A cell is the basic building block of a spreadsheet Each cell is designated by its location at the intersection of its column, denoted by a letter, and its row, denoted by a number This is referred to as the cell's address The cell address is always written with the column letter or letters first, followed by the row number — KB12 or G14, for example

Your computer screen is a "window" on your imaginary sheet of paper You can only see one small part of the spreadsheet through this window at a time The cursor indicates the cell where your work is going to be done next With an electronic spreadsheet, you can move, or "scroll" across the "surface" of the spreadsheet

An electronic spreadsheet program allows you to interact with the sheet, writing into the cells one of three things — a label (that is, a piece of text), a value (that is, a number, such as 420 00) or, and this is where a great deal of the power of the spreadsheet program lies, a formula which uses values in cells from another part of the sheet It is this feature that has made electronic spreadsheets important analytical tools. When you enter new values into the cells, you can instantly see their effect across the entire worksheet. All necessary recalculation is done automatically according to the formula defined for each cell. The spreadsheet organizes and calculates, analyzes and presents the results. Each of these capabilities can be easily adapted to your specific areas and tailored to your particular type of work.

One of the most important analytical applications of the spreadsheet is "what-if" analysis. What-if analysis allows you to quickly determine what will happen to a spreadsheet model if you change the underlying assumptions.

Given its power and versatility, a spreadsheet program is not limited to a single type of application It can be applied to the needs of the scientific, engineering and academic areas, as well as those of the business world.

As a very simple example of spreadsheet use, let us imagine that we wish to calculate the volume of water lost through a dripping tap for an hour or a day

It is advisable to put a heading on the spreadsheet. So in the first row, we enter the label WATER LOSS.

Into the three cells next to each other, we enter three labels -- one for TIME, one for FLOW and one for UNIT, e.g cells A3, B3 and C3. The labels allow us to identify what is in each column. This leaves row 2 empty and makes the final appearance neater

Then in the three cells, A4, A5 and A6, we enter MINUTE, HOUR and DAY, respectively. In cells C4 and C5, the unit of measurement is entered, i.e ML (millilitre). In cell C6, we enter the label LITRE In the cell B5, we would put a formula This would be +B4*60, which would mean: "Take the value in cell B4 and multiply by 60"

In cell B6, the formula +B5* 24/1000 is entered. This means "Take the value in cell B5 and multiply it by 24 and divide the result by 1000 (so that millilitre is converted to litre).

In most spreadsheets, the arithmetic calculations are performed left to right across the formula.

Now peep through the "window" and see how your model looks like.

	A	B	C
1	WATER LOSS		
2			
3	TIME	FLOW	UNIT
4	MINUTE	0	ML
5	HOUR	B4*60	ML
6	DAY	B5* 24/1000	L

See that no water is flowing through the tap, yet. So the cell B4 indicates 0 (zero)

Now you enter the amount of water that drips from the tap and your innocent looking model will wake up into action Suppose the amount of water that drips in one minute is 10 ML (which you have measured and then entered as a value in your spreadsheet at cell B4). The program will automatically calculate the values for B5 and B6, i e. the amount that flows in an hour and in a day respectively. Look again through the window

	A	B	C
1	WATER LOSS		
2			
3	TIME	FLOW	UNIT
4	MINUTE	10	ML
5	HOUR	600	ML
6	DAY	14 4	L

As the simple example now stands, we can see at a glance that the water loss for a minute is 10 ML, for an hour it is 600 ML and for a day it is 14 4 L. If we now discover that our figure for the flow per minute was wrong and in fact it should have been 7 ML and not 10 ML, we can simply change the value corresponding to FLOW to the required value The values for hour and day would then automatically change to 420 ML and 10.08 L.

The example looks incredibly simple. Doesn't it ? But extend the principle of this example and imagine that these figures are part of a larger table in which there are several taps for which we are calculating the total water loss and average loss. It is not difficult to see that a change in one figure which is wrongly entered might have irritating repercussions if the calculations are done by hand. Sometimes, it may be almost impossible

Before coming to use a spreadsheet as a classroom activity, several points should be considered.

First, is the spreadsheet suitable for the classroom activity you are proposing ? Does it have the capacity ? Will it let you enter all the formulae and data that will be required ?

Secondly, is it simple enough for the students to quickly grasp the method of operating the program ?

Lastly, before starting a spreadsheet you should start with a plan Construct on paper a rough model of what you are proposing. This will let you determine the layout of the model and make it easier to enter the data, labels and formula in the spreadsheet

For Additional Reading

1. *Business Applications on the BBC Micro*
   by Susan Curran and Margaret Norman
   Granada 1984

2 *Mastering SuperCalc 3*
   by Greg Harvey
   Sybex 1986.

Spreadsheet Simulation

Much too often we talk about the popularity of spreadsheets in business and administration and describe them as tools for producing well presented 'tables' which (unlike non-electronic tables) can be frequently changed and printed again by pressing this key or that. The tables that are built applying frivolous formulae are often trivial. The general emphasis, unfortunately, is on how a spreadsheet program can be made to run on the computer, not on what it really is and what it can be made to do in the classroom.

Electronic spreadsheets are not for neat and tidy tables A spreadsheet program is essentially a general purpose modelling tool that allows the user to formulate and test hypotheses. It can simulate diverse phenomena and processes and engage students in cause-effect analysis, it helps them explore their own ideas, stimulate discussion and demands a good deal of hands-off research.

Unlike a paper spreadsheet, the computer spreadsheet can simulate different types of dynamic processes Because one can quickly change the variables in a simulation and perform what-if analysis, a spreadsheet program involves students in problem solving methods as well as helps develop their inquiry skills That is why it is a powerful learning tool The ability of spreadsheets to quickly perform mathematical calculations allows students to concentrate on the problem and the simulation rather than on mathematics and calculations

Everyone wants a bigger, faster and more powerful program But it is important that you choose the one that suits your purpose best So choose it with care, ensure that it has those functions that you may require for your classroom activities Speed, of course, is an important consideration Some spreadsheets are as fast as rheumatic snails, some are faster I have for you a simple simulation as an example of classroom application of spreadsheet programs It is designed to study the well known relationship between the predator and the prey based on the model given below.

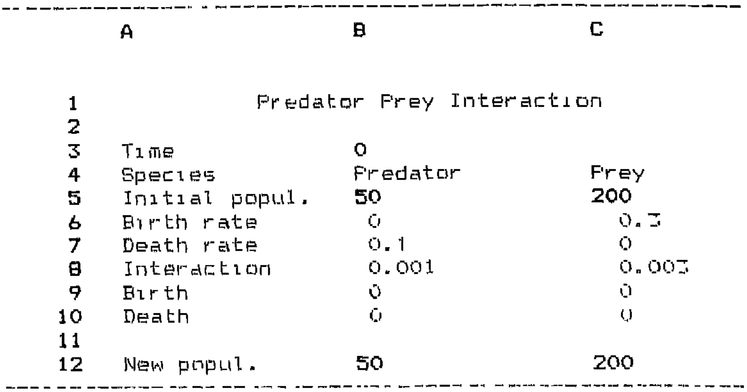
	A	B	C
1	Predator Prey Relationship		
3	Time	0	
4	Species	Predator	Prey
5	Initial Population	50	200
6	Birth Rate	0	0 3
7	Death Rate	0 1	0
8	Interaction	0 001	0 003
9	Birth	B3*B5*B6*B8	B3*C5*C6
10	Death	B3*B5*B7	B3*C5*C7*C8
12	New Population	B5+B9−B10	C5+C9−C10

If you change the value at B3 to some value greater than 0, the simulation begins

When the prey population is high, the predators thrive and thus increase in number As the predator population grows, however, the prey population declines Fewer prey means stravation for many of the predators So now the predator population falls With fewer predators around, the prey are able to re-establish themselves in large number, or so the model assumes The model also assumes that if the prey were left alone they would experience unrestricted growth at the birth rate as specified in C6, and that the predators have an intrinsic death rate, given in B7 The quantity in B8 is a measure of the predators in hunting prey, and the quantity in C8 is a measure of the probability that a prey individual will fail to escape an encounter with a predator

Using this simulation, you could follow the trajectory of this system for a complete cycle, modify the initial populations in B5 and C5 and draw other trajectories until a pattern emerges (Figures 5 1 and 5 2).

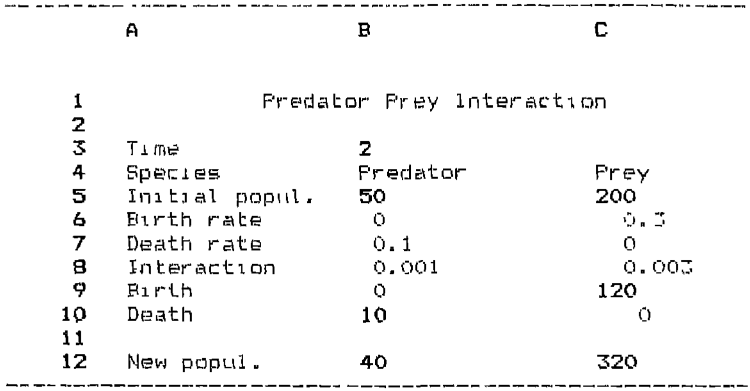
You have to try your own ideas and model them with the spreadsheet program that you have. Only then would you be able to integrate computer-based activities into what goes on



```
          A                    B                  C

 1              Predator Prey Interaction
 2
 3   Time                 0
 4   Species              Predator           Prey
 5   Initial popul.       50                 200
 6   Birth rate            0                   0.3
 7   Death rate            0.1                 0
 8   Interaction           0.001               0.003
 9   Birth                 0                   0
10   Death                 0                   0
11
12   New popul.           50                 200
```

(a)



```
          A                    B                  C

 1              Predator Prey Interaction
 2
 3   Time                 2
 4   Species              Predator           Prey
 5   Initial popul.       50                 200
 6   Birth rate            0                   0.3
 7   Death rate            0.1                 0
 8   Interaction           0.001               0.003
 9   Birth                 0                 120
10   Death                10                    0
11
12   New popul.           40                 320
```

(b)

Figure 5.1 Spreadsheet model of predator prey interaction, (a) represents the model at zero hour, i e before the interaction begins, and (b) after the lapse of 2 units of time

```
------------------------------------------------------------------
       A                  B                  C

 1            Predator Prey Interaction
 2
 3     Time               4
 4     Species            Predator           Prey
 5     Initial popul.     50                 200
 6     Birth rate          0                   0.3
 7     Death rate          0.1                 0
 8     Interaction         0.001               0.003
 9     Birth               0                 240
10     Death              20                   0
11
12     New popul.         30                 440
------------------------------------------------------------------
```

(a)

```
------------------------------------------------------------------
       A                  B                  C

 1            Predator Prey Interaction
 2
 3     Time               4
 4     Species            Predator           Prey
 5     Initial popul.     50                 300
 6     Birth rate          0                   0.3
 7     Death rate          0.1                 0
 8     Interaction         0.001               0.003
 9     Birth               0                 360
10     Death              20                   0
11
12     New popul.         30                 660
------------------------------------------------------------------
```

(b)

Figure 5.2 The same spreadsheet model (as the one in Fig. 5.1) after an elapsed time of 4 units (a) with all other conditions remaining the same, (b) with initial prey population altered,

```
--------------------------------------------------------------------------------
         A                    B                    C

 1                Predator Prey Interaction
 2
 3       Time                 4
 4       Species              Predator             Prey
 5       Initial popul.       50                   200
 6       Birth rate            0                     0.6
 7       Death rate            0.1                   0
 8       Interaction           0.001                 0.003
 9       Birth                 0                   480
10       Death                20                     0
11
12       New popul.           30                   680
--------------------------------------------------------------------------------
```

(c)

```
--------------------------------------------------------------------------------
         A                    B                    C

 1                Predator Prey Interaction
 2
 3       Time                 4
 4       Species              Predator             Prey
 5       Initial popul.       50                   200
 6       Birth rate            0                     0.3
 7       Death rate            0.2                   0
 8       Interaction           0.001                 0.003
 9       Birth                 0                   240
10       Death                40                     0
11
12       New popul.           10                   440
--------------------------------------------------------------------------------
```

(d)

Fig 5 2 Contd
(c) with the birth rate of the prey population altered (from 0 3 to 0 6 and (d) with the death rate of the predator population changed (from 0.1 to 0 2)

in your classroom and into whatever you happen to be interested in — population statistics, monthly weather average, irrigation or loss of water through faulty faucets.

Suggested Activities

1. Get acquainted with the spreadsheet program available
2. Use a spreadsheet prepared by your instructor; change formulae and values.
3. Prepare a spreadsheet using your own formulae and model and simulate a situation from your area of specialization

MODULE 6: EVALUATING SOFTWARE

Aims of this module:

1. to acquaint you with various features of software/courseware
2. to enable you to evaluate software or courseware on the basis of those features.

Objectives of this module Having done the activities indicated in this module, you should be able to .

1. describe a piece of software/courseware on the basis of hardware requirement, package content/structure, its educational value, etc
2. describe the overall technical characteristics of a program

Evaluating Software

One of the many remarkable qualities that all educators, most teachers and some parents have in common is that each one of them knows how children learn Naturally, there is no dearth of theories of learning and none of them is to be gainsaid.

Now, if you are adequately influenced by one (or more) of these theories, then picking up instructional software off the shelf is a relatively easy job make a checklist of desired features and see if they are reflected in the program that you are about to buy or use in your classroom

Unfortunately, there are others who tend to believe that the process of learning is not so well known as is usually claimed. Therefore, the job of selecting a software package, which would be an appropriate aid to a learning process or would motivate the learner, is extremely difficult In some ways it is much more difficult than choosing software for an office payroll or a bank where the requirements are easy to describe.

How does one make a selection then ? There is an enormous variety of software available, one can never rely on a single evaluation tool to assess their usefulness in the classroom. So there have been innumerable ways in which people have tried to evaluate educational software. Most of them, however, tend to judge the more technical aspects of the program For example, whether the program in question appropriately uses graphic, colour and sound facilities, if the screen instructions are friendly enough for the user, whether the accompanying notes are of any use, etc. Yet the sum of the answers to these questions do not tell you the whole truth about a package Nothing will, until you have used it and re-used it and used it again The package should suit you and your needs no matter what others say about it.

In fact, evaluating educational software fully and fairly is no mean task The following set of criteria for evaluation are presented, not as a definitive standard, but in the spirit of exploration for one You may take it as a buyer's guide

The primary role of the computer in education is to enhance and improve, not merely to automate So you must take great care not to be so dazzled by the technical virtuosity of the medium that you cannot see the educational implications of the package Answers to the following questions may be a reliable guide

Is the software appropriate for the school machine?

One should be very careful about the software designed for compatibility with different hardware Even for the same computer, there may be different versions of a software

Does the software exploit the machine's capabilities?

In micros, input can be through paddles, joysticks, light pen, etc. as well as through keyboards Output can be as graphics, animation, colour and sound, as well as text, or, via an interface, through other presentation devices Powerful software is available which requires some of these input or output devices for some particular programs If the school has some of these peripherals, the wider options for picking up software should be carefully weighed while making a choice

Is the software well documented ?

One should be on guard against documentation that employs statements such as 'The package is designed to assist young children in developing such fundamental skills' and never describing exactly what it does Documentation should be clear for the user and describe features of the program and indicate its limitations.

Will children be able to use the program easily ?

It is important to examine very closely whether the software has been designed with careful consideration of the intended user, or only the machine has been considered

Is the software appropriate for the intended teaching situation?

Sometimes, the limitations of a software tend to dictate the teaching situation which may not be congenial to the user.

Is the subject matter accurate, complete and properly sequenced ?

Does it actually provide concrete access to knowledge that is otherwise available only through formal processes ? Although applicable to almost all categories of software, this criterion mainly pertains to tutorial and drill-n-practice programs

Does the software promote activities away form the computer?

If educational computing is to be a part of the total curricular exercise, computer software should be used only when it proves more useful than other methods If so, all software should make room for, and encourage, activities away from the computer program — to be carried out without the machine Conversely, some exploratory activities carried out earlier could be preparatory to the subsequent processing of findings through a computer program

Finally, you should see that a courseware contributes to thinking, and is substantial, and does not teach trivia And be sure that it is not an animated textbook.

For Additional Reading

1 *Quality Assurance for Computer Software*
by Robert Dunn and Richard Ullman.
McGraw - Hill 1982

2 *Courseware in the Classroom*
by Ann Lathroys and Bobby Goodson
Addison Wesley 1983

3. *A Parent's Guide to Educational Software*
Edited by Bill Tagg
Telegraph Publication 1985

For a Closer Scrutiny

Well, that was a buyer's guide — hopefully a useful one. But you need to take a closer look at every package that you want to procure for your school.

Micros can assist the instructional process effectively only to the extent that quality software is available. The more knowledgeable and discriminating you are when selecting software for your classroom use, the better the quality of software used in your class. You are expected to be able to objectively judge the instructional worth of the software or courseware you pick up (courseware is software plus printed materials which support instruction in a course of study or a defineable subset of a course). But decisions are not always easy to make and the need to justify those decisions will be growing as the number of instructional packages available off the shelf grows. I hope this part of the module will increase your awareness of what to look for in high-quality courseware which will reinforce your undoubted knowledge of sound teaching practices.

It is rather too common to supply structured evaluation sheet for teachers to tick and cross. I believe, that is a sure way of restricting the spontaniety of your response and it leaves you with the feeling that you haven't said all that you wanted to say. Instead, therefore, I have put a series of questions and suggestions/comments on various aspects of courseware. If you try to answer those questions and put down your responses to my suggestions/comments, you are more likely to end up with a coherent report on the courseware that you intend to evaluate.

Most courseware includes a printed documentation as well as the disk on which the program is inscribed. Examine both and follow the pathway indicated below and write down your report. All the following items may not be relevant to all packages. Use your judgement on the extent of your report.

I. Courseware Description

Grade/ability level: Describe the grade level, grade range and other ability level indicators for which the package is intended.

Required hardware: Identify the minimum hardware required for the use of the package:

i Computer
ii. RAM amount
iii. Mass storage devices (disk)
iv. Output devices (colour or black and white monitor or TV, printer)
v Other peripherals (joystick, paddles)
vi. Special electronics (circuit card, interfaces)

Required software: Identify operating system and utility software that might be required to install and use the software.

Instructional purpose and techniques: Check all items in the printed documentation that describe the techniques employed in the package. If these are not indicated, find out for yourself using the program.

Documentation. Against the item 'documentation' of the package, mark S if the documentation is in printed supplementary materials, mark P if the item is contained in the program

Objective. List the purpose, goals, or objectives that are intended to be achieved through the package.

Prerequisite: Describe the experiences, skills, concepts, understanding, maturity and ability levels which the intended user should posses for successful use of the package.

II Package Content and Structure

Abstract of content· This information should be available in the material provided by the producer of the package However, you may wish to add comments if the description is in-complete or inaccurate Some suggested components of the description could be:

General content: Describe the general content of the package.

The user's role: Describe the dimension of user control over rate, sequence, amount, type and problem examples, if applicable. For example, "The user determines how much time will be allowed for solving each problem."

Instructional strategy: It is obvious that the instructional strategy for a drill and practice program would be altogether different from the one for a simulation program A drill and practice program, for example, may be designed to increase the student's proficiency and speed in solving problems related to, say, matching of blood groups. On the other hand, a simulation program may simulate a malaria control situation by determining cost effectiveness and impact of the variables selected by the user.

Such different kinds of programs call for differential strategies They should be clearly indicated.

Instructional integration: Describe the degree to which the package is or can be an integral part of instruction. For example, it may be intended as a random or casual supplement, chosen by the teacher or students as one of several options On the other hand, it may be the only way an important topic can be addressed with a student activity.

Program structure: Describe the flow or sequence of activity in the program.

III Courseware Evaluation

In this section, some positive statements have been made with regard to a number of features of a courseware. If you agree with the initial comment in each case (in italics), then copy that comment straight away. Where you do not agree with that, note down specific reasons for your disagreement In some cases, further specifications under each comment will help you indicate your reasons for disagreement.

A. Content Characteristics

1. The content is accurate. If you think this statement is true, just copy it down on your evaluation sheet; if not, quote specific examples of lapses from the following variety:

i. Outdated information or instructional approach
ii. Factual errors
iii. Invalid model used in a simulation
iv. Oversimplified model or example
v. Improper use of statistics
vi. Inaccurate graphs or displays

2 The content has educational value If you think it does not, indicate that.

Any decision on this item will always be subjective. Some considerations leading to a positive judgement might include:

i The content and objectives are addressed in common school curricula
ii. The knowledge and skills involved have some utility
iii. An instructional situation can be envisioned in which the package would be useful
iv Use of the package enables you to learn something about the nature or needs of the students using it
v The content of the package is central to the subject field.

3 The content is free of race, sex and other stereotypes If not, say so.

4. The purpose of the package is well defined If this is not so, then make a note Remember,

i Objectives should be explicit, rather than inferred
ii. Objective statements should be clear
iii. Objectives should be stated in terms of expected student behaviour.

5 *The package achieves its defined purpose.* If not, indicate that.

6 *Presentation of content is clear and logical.* If not, indicate that.

7 *The level of difficulty is appropriate for the target audience.* If not, indicate that

8. *Graphics/colour/sound are used for appropriate instructional reasons.* If not, indicate that.

9 *Use of the package is motivational.* If not, indicate that.

10. *The rate and sequence of presentation is learner-controlled.* If not, indicate that.

B. Technical Characteristics

1. The user support materials are comprehensive If not, indicate itemwise.

i. *Student materials.* Find out whether the package includes sufficient materials for student activities, e.g. pre-instruction activities relating to the package, a guide to the use of the package, worksheets, etc.

ii *The teacher's information* Likewise, materials for teachers should include a discription of instructional activities, suggestions for classroom logistics, a rationale for computer use, teacher-direted pre- and post-instructional activities, etc

iii *Resource information.* This includes bibliography of resources and references related to the content, results of the sample run of the program and, where applicable, a description of the model used in simulation

iv *Technical documentation:* This should explain how the program and the package operate, provide explanation of user-defineable option to adapt the program for different applications, explanation of the software/hardware interface or any other extraordinary feature of the program and interpretation of error messages.

2. *The user support materials are effective.*

i. The quality of papper and print are good.
ii. Texts, captions, labels are thoroughly edited.
iii. The packaging of the material is suitable for the intended use.

If they are not so, write your comment

3. *Information displays are effective*

i. Graphics displays are not too complex.
ii Text narrative is clear and easy to read.
iii The user is given adequate time to read and absorb the information given in the displays and graphics

If they are not so, indicate that with specific examples.

4 *Intended users can easily and independently operate the program.*

i. The program has enough built-in documentation to permit ease of use even without external paper documentation.
ii Help pages and functions are provided and are accessible at likely points of need.
iii. The program does not allow the user to get lost in it with no apparent way out. The student always has some options for getting the program running again, or returning to a beginning point
iv. Error-trapping devices are effective.
v. Instructions and error messages are clear and unambiguous.
vi. Computer operation does not interfere with concentration on activity.

If you disagree, indicate specific reasons.

5. *The teacher can easily employ the package.*

The program can be used by a person having a minimum of computer comprehension. Software modifications or any unusal modifications of disks are not required to use the program effectively.

If you think otherwise, note that down.

6 The program appropriately uses relevant computer capabilities.

Software should take full advantage of the unique aspects of the computer. The application should be well suited to computer use.

If you think otherwise, say so.

7. The program is reliable in normal use

The program will consistently run under all normal conditions. It is free of programming and operational errors

If you think the program is not so, note it down

Now take a look at what you have jotted down. It should look like a comprehensive evaluation report

Suggested Activities

1 Pick up an instructional package and run the program.
2. Re-run the program and go through its printed documentation.
3. Write a comprehensive report of the package and discuss with colleagues on its strengths and weaknesses.

GLOSSARY

A

Application software
is a set of specialized programs to carry out a particular application A payroll program, computer graphics or word processing programs are examples of application software

Arithmetic Logic Unit (ALU)
is the part of the central processing unit (of a computer) where arithmetic/logic operations are performed.

Authoring language
is a formal language used in the context of CAL with particular properties appropriate to the development of curriculum material

B

Back-up copy
is a copy of a file that is taken in case the original is altered (unintentionally) or destroyed and the data lost A floppy disk may be copied for the same reason When a copy is made, it is said to be a *back-up* of the original version.

Bit
is short for binary digit It is one of the digits used in binary notation, i e 0 or 1 It is the smallest unit of storage

Byte
is a fixed number of bits, often corresponding to a single character

C

CAL
is abbreviation for computer-assisted learning The term pertains to any use of computers to aid or support the education and training of people

CAI
is abbreviation for computer-aided instruction It represents an educational concept which places the learner in a conversational mode with a computer that has a pre-programmed study plan

Character
is any symbol used in representing and organizing data A character may be one of the 26 letters of the alphabet, one of the digits 0-9, a punctuation mark, bracket, etc In the world of computers, A and a are different characters

Circuit card
is a rigid card of insulating material on which an electric circuit has been or can be built

Clock
is the reference timing source in a system, usually expressed in Megahertz (MHz) A clock provides regular pulses which trigger or synchronize events Most microprocessor clocks operate in the range of 1 to 10 MHz

Command
is the portion of an instruction word which specifies the operation to be performed

Computer
is a machine which, under the control of a stored program, accepts and processes data and supplies the results of that processing

Computer system
is a central processor together with its associated peripheral equipment It is the complete assembly, hardware and software, with CPU, memory and I/O, plus any other device for an intended application

CPU
is abbreviation for central processing unit It is the computer module in charge of fetching, decoding and executing instructions It contains a control unit, an ALU and other related facilities

D

Data
denotes any or all facts, numbers, letters and symbols that refer to or describe an object, idea, condition, situation or other factors suitable for communication, interpretation or processing by people or by automatic means

Database
is a collection of structured data The structure of the data is independent of any particular application.

Data capture
is the action involved in collection of data for use in a particular computer processing

DbMS
is abbreviation for database management system. It is a suite of programs providing a general mechanism for systematic storage and retrieval of data from a database

Data retrieval
is the process by which data is selected and extracted from a file or a database

Disk
is a flat, circular magnetic storage medium

Documentation
is print material needed to document a computer application, including (usually) problem-statement, flowcharts, coding and operating instructions

Dot matrix
is formation of characters by using many small dots Usual patterns are 5 by 7 or 7 by 9.

E

Error trapping
is any of a variety of programming devices used to check data from certain kinds of errors that may have occurred, say, during the transfer of data

F

Field
is a portion of a record It contains a fixed or variable number of letters, digits or other characters

Function keys
send not one but a whole sequence of characters (unlike ordinary keys) to the computer at a time, and can often be programmed by the user

G

Graphics
is the representation of information by a computer in graphical form, the display being either as charts or diagrams on paper or as animation on a computer monitor

H

Hardware
is the physically existing components of a computer system, e g the box, chips, wires, nuts and bolts

I

Information
is the meaning given to data by the way in which it is interpreted

Input device
is a peripheral unit which can accept data presented in a machine-readable form, decode it and transmit it as electrical pulses to the CPU

Integrated circuit
is a solid state microcircuit consisting of inter-connected semiconductor devices diffused into a single silicon chip

Interface
is the hardware and associated software needed between processors and peripheral devices, to compensate for the difference in their operating characteristics

J

Joystick
is a device for analogue-to-digital conversion where input is the movement of a control lever in two dimensions

K

Keyboard
is a group of buttons on a pad used to input information into a computer system manually A computer keyboard consists of the standard typewriter layout

Kilobyte
literally means a thousand bytes In reality, it is 2^{10} or 1024 bytes

L

Light pen
is a device which, when placed against a monitor screen, can be tracked by the computer It is used to select data on the monitor and sometimes to trace information as input to a program

M

Memory
is the storage facility of a computer, capable of storing a definite amount of data

Microcomputer
is a computer based on a microprocessor Generally this is a relatively cheap and slow computer with a limited memory, a simple instruction set and elementary backing store (e g floppy disks, cassette tapes)

Monitor
is a black-and-white or colour display device (like a TV) used for display of computer output

O

Operating system
is the software required to manage the hardware and logical resources of a computer system, including device handling, process scheduling and file management

Output device
is a peripheral unit which translates signals from the computer into a human-readable form or into a form suitable for re-processing by the computer at a later stage

P

Paddle
is a general name for a hand-held control device used for computer games

Page
is a screenful of information

Parallel port
is a device for getting signals running in parallel — meaning that a number of signals travel through the port at once (as opposed to serial port, through which the signals travel one after the other)

Peripheral
is the term used to describe an input, output or backing storage device which can be connected to the CPU

Pixel
is a contraction of 'picture element' As used in graphics, it is the smallest element of a display

Printer
is an output device producing characters or graphic symbols on paper

Program (note spelling)
is a complete set of instructions or statements structured in such a way as to specify an algorithm

Programming language
is an artificial language constructed in such a way that people and programmable machines can communicate with each other in a precise way

R

RAM
Stands for random access memory, which may be read from and written to by the programmer It is usually made on a chip Random access is an access method where each word can be retrieved directly by its address, independent of any other word

Record
is a collection of related items of data, treated as a unit

Resolution
is the amount of information or detail that can be produced by a device such as a monitor With a graphic display, the resolution can be quoted as the number of pixels that are available in the horizontal and vertical directions of a screen, e g 1024 by 768 pixels

Robot
is a mechanical device which can be programmed to perform some task of manipulation or locomotion under automatic control

ROM
is abbreviation for read only memory The programmer cannot write on a ROM The software in the ROM is fixed during manufacture. However, the user can read (and use for definite purpose) what the software has to offer

S

Scrolling
is the movement of contents of the monitor (screen) up or down by one or more lines

Serial port
(see Parallel port)

Simulation
is the imitation of a certain behaviour of a system, or of some aspect of that behaviour, by another system The imitation may be in the form of a model that can be manipulated by a computer or the imitation may be achieved by a device under the control of a computer

Software
is the instruction that tells the hardware what to do with data Software is not a physical component

Spreadsheet
is a program that manipulates tables consisting of rows and columns of cells and displays them on a screen The cells contain numerical data and formulae, or text A spreadsheet can be used for 'what-if' analysis and many other applications involving tables of numbers with interdependent rows and columns It is commonly used as a general purpose simulation tool

U

Utility software
is a program designed to perform a commonplace task such as the transfer of data from one storage device to another or sorting a set of data

W

Window
is a section of a monitor screen dedicated to displaying specific types of information

Word processor
is a computer program for writing, editing and formatting letters, reports and books

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